CBSE

GRAVITATION WS 1

Class 11 - Physics

Section A

1. Kepler discovered: **[1]**

   a) laws of rotational motion
   b) laws of curvilinear motion
   c) laws of motion
   d) laws of planetary motion

2. If a new planet is discovered rotating around the sun with the orbital radius double that of earth, then what will be its time period (in earth's days)? **[1]**

   a) 1024
   b) 1043
   c) 1032
   d) 1023

3. The velocity of the planet when it is closest to sun is **[1]**

   a) Zero
   b) can have any value
   c) minimum
   d) maximum

4. The law of areas can be interprted as **[1]**

   a) $\frac{\Delta A}{\Delta t} = \frac{L}{m}$
   b) $\frac{\Delta A}{\Delta t} = \frac{1}{2}(r \times p)$
   c) $\frac{\Delta A}{\Delta t} = \frac{2L}{m}$
   d) $\frac{\Delta A}{\Delta t}$ = constant

5. Average distance of the earth frorn the sun is L_1. If one year of the earth = D days, one year of another planet whose average distance from the sun is L_2 will be: **[1]**

   a) $D\left(\frac{L_2}{L_1}\right)^{\frac{1}{2}}$ days
   b) $D\left(\frac{L_2}{L_1}\right)^{\frac{2}{3}}$
   c) $D\left(\frac{L_2}{L_1}\right)^{\frac{3}{2}}$ days
   d) $D\left(\frac{L_2}{L_1}\right)$

6. The maximum and minimum distances of a comet from the Sun are 8×10^{12} m and 1.6×10^{12} m. If its velocity when nearest to the Sun is 60 ms^{-1}, be its velocity in ms^{-1} when it is farthest? **[1]**

   a) 6
   b) 60
   c) 12
   d) 112

7. The area ΔA swept out by a planet of mass m in time interval Δt is related to the angular momentum by: **[1]**

   a) $\Delta A/\Delta t = gL/(2m)$
   b) $\Delta A/\Delta t = 2L/m$
   c) $\Delta \mathbf{A}/\Delta t = GL/(2m)$
   d) $\Delta A/\Delta t = L/(2m)$

8. A body is projected from earth's surface to become its satellite. Its time period of revolution will not depend upon: **[1]**

   a) mass of earth
   b) its own mass

c) gravitational constant
d) radius of earth

9. Consider a spacecraft in an elliptical orbit around the earth. At the low point, or perigee, of its orbit, it is 400 km above the earth's surface; at the high point, or apogee, it is 4000 km above the earth's surface. Using conservation of energy, find the speed at perigee and the speed at apogee. It is necessary to have the spacecraft escape from the earth completely. **[1]**

a) 9840 m/sec(perigee),9760 m/sec(apogee)
b) 7840 m/sec(perigee),5760 m/sec(apogee)
c) 10840 m/sec(perigee),8760 m/sec(apogee)
d) 8840 m/sec(perigee),6760 m/sec(apogee)

10. Kepler's second law is based on: **[1]**

a) Newton's first law
b) Newton's second law
c) Conservation of angular momentum
d) Special theory of relativity

11. In our solar system, the inter-planetary region has chunks of matter (much smaller in size compared to planets) called asteroids. They **[1]**

a) will move in orbits like planets and obey Kepler's laws
b) will move in an irregular way because of their small masses and will drift away into outer space.
c) will move around the sun in closed orbits but not obey Kepler's laws.
d) will not move around the sun since they have very small masses compared to sun.

12. A planet moves around the sun. It is closest to sun at a distance d_1 and has velocity v_1 and farthest with distance d_2, its speed at this point will be: **[1]**

a) $\frac{d_2 v_1}{d_1}$
b) $\frac{d_1 v_1}{d_2}$
c) $\frac{d_2^2 v_1}{d_1^2}$
d) $\frac{d_1^2 v_1}{d_2^2}$

13. For a satellite in elliptical orbit which of the following quantities does not remain constant? **[1]**

a) All of these
b) Linear momentum
c) Areal velocity
d) Angular momentum

14. What is not conserved in the case of celestial bodies revolving around sun? **[1]**

a) linear momentum
b) kinetic energy
c) angular momentum
d) mass

15. Both earth and moon are subject to the gravitational force of the sun. As observed from the sun, the orbit of the moon **[1]**

a) will be elliptical
b) is not elliptical but will necessarily be a closed curve
c) deviates considerably from being elliptical due to influence of planets other than earth
d) will not be strictly elliptical because the total gravitational force on it is not central

16. The distances of two planets from the sun are 10^{13} m and 10^{12}m respectively. The ratio of time periods of the planets is: **[1]**

a) 10
b) $\sqrt{10}$

c) $\frac{1}{\sqrt{10}}$ d) $10\sqrt{10}$

17. The radius vector, drawn from the sun to a planet sweeps out equal areas in equal times. This is the statement of: **[1]**

a) Newton's third law b) Kepler's third law

c) Kepler's second law d) Kepler's first law

18. If the radius of earth's orbit is made one-fourth, then duration of one year will become: **[1]**

a) $\frac{T^2}{R^2}$ b) $\frac{T^2}{R}$

c) $\frac{T}{R}$ d) $\frac{T^2}{R^3}$

19. According to Kepler's laws, which of the following is correct? (where T is the time period of rotation around sun and R is the average distance between planet and sun.) **[1]**

a) $T \propto R^3$ b) $T \propto R^{\frac{2}{3}}$

c) $T \propto R^{\frac{3}{2}}$ d) $T \propto R^2$

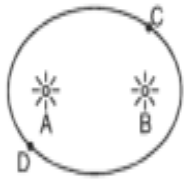
20. Consider a spacecraft in an elliptical orbit around the earth. At the low point, or perigee, of its orbit, it is 400 km above the earth's surface; at the high point, or apogee, it is 4000 km above the earth's surface. It is necessary to have the spacecraft escape from the earth completely. If the spacecraft's rockets are fired at perigee, by how much would the speed have to be increased to achieve this? If the spacecraft's rockets are fired at apogee, by how much would the speed have to be increased to achieve this? **[1]**

a) 3410 m/sec(perigee), 6761 m/sec(apogee) b) 2410 m/sec(perigee),8761 m/sec(apogee)

c) 5410 m/sec(perigee), 8761 m/sec(apogee) d) 4410 m/sec(perigee), 7761 m/sec(apogee)

21. If the earth be one-half its present distance from the sun, how many days will the present one year on the surface of the earth change? **[1]**

22. Identify the position of sun in the following diagram if the linear speed of the planet is greater at C than at D. **[1]**



23. The largest and shortest distances of the earth from the sun are r_1 and r_2 respectively. What is the distance from the sun when it is perpendicular to the major axis of the orbit from the sun? **[1]**

24. What is the basis of Kepler's law of areas of planetary motion? **[1]**

25. Can we determine the mass of a satellite by measuring its time period? **[1]**

26. What is the direction of areal velocity of the earth around the sun? **[1]**

27. A planet moving along an elliptical orbit is closest to the Sun at a distance r_1 and farthest away at a distance of r_2. If v_1 and v_2 are the linear velocities at these points respectively, then find the ratio $\frac{v_1}{v_2}$. **[1]**

28. From Kepler's second law and observations of the sun's motion as seen from the earth, we can conclude that the earth is closer to the sun during winter in the Northern hemisphere than during summer. Explain. **[1]**

29. On which fundamental law of physics is Kepler's second law based? **[1]**

30. The linear speed of a planet is not constant in its orbit. Comment. **[1]**

31. What is the time period of a simple pendulum at the centre of the earth? **[1]**

32. Imagine a light planet revolving around a massive star in a circular orbit of radius r with a period of revolution T. **[1]**

If the gravitational force of attraction between the planet and the star is proportional to $r^{-5/2}$, then find the relation between T and r.

33. A planet of mass m moves around the sun of mass M in an elliptical orbit. The maximum and minimum distances of the planet from the sun are r_1 and r_2 respectively. Find the relation for the time period of the planet in terms of r_1 and r_2. **[1]**

34. The distances of two planets from the sun are 10^{11} m and 10^{10} m respectively. What is the ratio of time period of these two planets? **[1]**

35. A binary star system consists of two stars A and B which have time periods T_A and T_B, radius R_A and R_B and masses m_a and m_e which of the three quantities are same for the stars. Justify. **[1]**

36. The radius of earth's orbit is 1.5×10^8 km and that of Mars is 2.5×10^{11} m. In how many years, does the Mars complete its one revolution? **[1]**

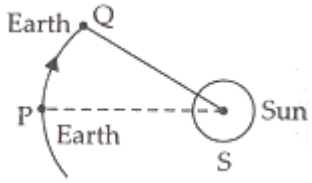
Section B

37. State and explain Kepler's laws of planetary motion. Name the physical quantities which remain constant during the planetary motion. **[2]**

38. If T be the period of a satellite revolving just above the surface of a planet, whose average density is ρ, show that ρT^2 is a universal constant. **[2]**

39. Suppose the gravitational force varies inversely as the nth power of distance. Then, find the expression for the time period of a planet in a circular orbit of radius r around the sun. **[2]**

40. Mean solar day is the time interval between two successive noon when the sun passes through the zenith point (meridian). The sidereal day is the time interval between two successive transit of a distant star through the zenith point (meridian). **[2]**



In drawing appropriate diagram showing earth's spin and orbital motion, show that the mean solar day is four minutes longer than the sidereal day. In other words, distant stars would rise 4 minutes early every successive day.

[Hint: you may assume a circular orbit for the earth.]

41. The radius of the earth's orbit around the sun is 1.5×10^{11} m. Calculate the angular and linear velocity of the earth. Through how much angle does the earth revolve in 2 days? **[2]**

42. Out of aphelion and perihelion, where is the speed of the earth more and why? **[2]**

43. State and derive Kepler's law of periods (or harmonic law) for circular orbits. **[2]**

44. **Weighing the Earth:** You are given the following data: $g = 9.81\ ms^{-2}$, $R_E = 6.37 \times 10^6$ m, the distance to the moon $R = 3.84 \times 10^8$ m, and the time period of the moon's revolution is 27.3 days. Obtain the mass of the Earth M_E in two different ways. **[2]**

45. Express the constant k in equation $T^2 = k(R + h)^3$ in days and kilometres. Given, $k = 10^{-13}\ s^2/m^3$. The moon is at a distance of 3.84×10^5 km from the earth. Obtain its time period of revolution in days. **[2]**

46. Show that an artificial satellite circling around the earth in an orbit of radius obeys Kepler's third law. **[2]**

47. The asteroid Pallas has an orbital period of 4.62 yr. Find the semi-major axis of its orbit. Given, $G = 6.67 \times 10^{-11}$ **[2]**

Nm kg^{-2}, mass of the sun = 1.99×10^{30} kg and 1 yr = 3.156×10^{7} s.

48. State and briefly explain the law of areas. **[2]**

49. What is Kepler's law of periods? Show it mathematically. **[2]**

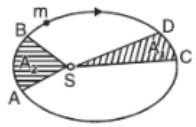
50. In kepler's law of period, $T^2 = kr^3$, the constant, $k = 10^{-13}s^2m^{-3}$. Express the constant, k in days and kilometres. **[2]**

The moon is at a distance of 3.84×10^5 km from the earth. Obtain its time period of revolution in days.

51. i. According to Kepler's second law, the radius vector to a planet from the sun sweeps out equal areas in equal interval of time. The law is consequence of which conservation law? **[2]**
ii. State Kepler's third law.

52. The distance of the planet Jupiter from the sun is 5.2 times that of the earth. Find the period of the Jupiter's revolution around the sun? **[2]**

53. The figure shows elliptical orbit of a planet m about the sun S. The shaded area of SCD is twice the shaded area SAB. If t_1 is the time for the planet to move from D to C and t_2, is time to move from A to B, what is the relation between t_1 and t_2? **[2]**



54. State and explain Kepler's first law of planetary motion. **[2]**

55. The mean orbital radius of the earth around the sun is 1.5×10^8 km. Calculate mass of the sun if G = 6.67×10^{11} Nm^2/kg^{-2}? **[2]**

56. Draw areal velocity versus time graph for mars. **[2]**

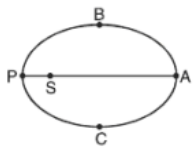
57. In an imaginary planetary system, the central star has the same mass as our sun, but is brighter so that only a planet twice the distance between the earth and the sun can support life. Assuming biological evolution (including aging process etc.) on that planet similar to ours, what would be the average life span of a **human** on that planet in terms of its natural year? The average life span of a human on the earth may be taken to be 70 years. **[2]**

58. Calculate the period of revolution of the Neptune around the sun given that diameter of its orbit is 30 times the diameter of the earth's orbit around the sun. Assume both the orbits to be circular. **[2]**

Section C

59. A Saturn year is 29.5 times the earth year. How far is the Saturn from the sun if the earth is 1.50×10^8 km away from the sun? **[3]**

60. Let the speed of the planet at perihelion P in fig be v_p and Sun planet distance SP be r_p. Relate (r_p, v_p) to the corresponding quantities at the aphelion (r_A, v_A). Will the planet take equal times to traverse BAC and CPB? **[3]**



61. How much faster than the present speed should the earth rotate so that bodies lying on the equator may fly off into space. **[3]**

62. i. State Kepler's laws of planetary motion. **[3]**
ii. Suppose there existed a planet that went round the sun twice as fast as the earth. What will be its orbital size as compared to that of the earth.

63. The planet Mars has two moons, Phobos and Deimos. **[3]**

a. Phobos has a period 7h, 39 min and an orbital radius of 9.4×10^3 km. Calculate the mass of mars.

b. Assume that earth and mars move in circular orbits around the sun with the Martian orbit being 1.52 times the orbital radius of the earth. What is the length of the Martian year in days?

64. How will you weigh the sun, that is estimate its mass? The mean orbital radius of the earth around the sun is 1.5×10^8 km. **[3]**

65. Imagine a tunnel dug along a diameter of the earth. Show that a particle dropped from one end of the tunnel executes simple harmonic motion. What is the time period of this motion? Assume the earth to be a sphere of uniform mass density (equal to its known average density = 5520 kg m^{-3}.) G = 6.67×10^{-11} Nm^2kg^{-2}. Neglect all damping forces. **[3]**

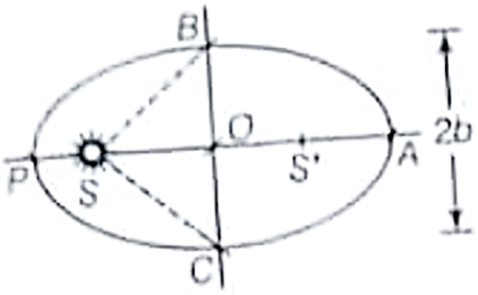
66. If the period of revolution of an artificial satellite just above the earth's surface be T and the density of earth be ρ, then prove that ρT^2 is a universal constant. Also calculate the value of this constant. Given: G = 6.67×10^{-11} m^3 kg^{-1} s^{-2}. **[3]**

67. Earth's orbit is an ellipse with eccentricity 0.0167. Thus, the earth's distance from the sun and speed as it moves around the sun varies from day to day. This means that the length of the solar day is not constant throughout the year. Assume that the earth's spin axis is normal to its orbital plane and find out the length of the shortest and the longest day. A day should be taken from noon to noon. Does this explain the variation of length of the day during the year? **[3]**

Section D

Question No. 68 to 72 are based on the given text. Read the text carefully and answer the questions: **[5]**

Let the speed of the planet at the perihenont above figure be v_p and the Sun planet distance SP. be r_p. The corresponding quantity at the aphelion A is (r_A, v_A). The mass of the planet in m_p.



68. The magnitude of the angular momentum at P is:

a) $L_p = \frac{m_e r_e}{v_p}$ b) $L_p = \frac{m_p v_p}{r_p}$

c) $L_p = m_p V_p$ d) $L_p = m_p r_p v_p$

69. The magnitude of the angular momentum at A is:

a) $L_A = m_p r_A v_A$ b) $L_x = \frac{m_P f_A}{v_A}$

c) $L_A = \frac{m_p v_A}{r_A}$ d) $L_A = m_p v_A$

70. The vectors r_p, and v_p, are

a) coincident b) anti-parallel

c) mutually perpendicular d) parallel

71. The relation for conservation of angular momentum at P and A is:

a) $\frac{m_p v_p}{r_p} = \frac{m_p V_A}{r_A}$ b) $m_p r_p v_p = m_p F_A v_A$

c) $\frac{m_p r_p}{v_p} = \frac{m_p r_A}{v_A}$ d) $m_p v_p = m_p v_A$

72. The magnitude of angular momentum as the planet goes round the sun is:

a) increases as planet goes near to sun b) depends on magnitude of velocity

c) variable d) constant

73. Let us assume that our galaxy consists of 2.5×10^{11} stars each of one solar mass. How long will a star at a distance of 50,000 ly from the galactic centre take to complete one revolution? Take the diameter of the Milky Way to be 10^5 ly. **[5]**

74. A satellite is in an elliptic orbit around the earth with aphelion of 6R and perihelion of 2R where R= 6400 km is the radius of the earth. Find eccentricity of the orbit. Find the velocity of the satellite at apogee and perigee. What should be done if this satellite has to be transferred to a circular orbit of radius 6R? [G = 6.67 $\times$ 10^{-11} SI units and M = 6 $\times$ 10^{24} kg] **[5]**

75. State Kepler's laws of planetary motion. Deduce Newton's law of gravitation from Kepler's law. **[5]**